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METROPOLITAN INDIANAPOLIS AIR POLLUTANT EMISSION INVENTORY

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16. Abstracts

A rapid survey was made to outline the sources and emissions of air pollutants. Estimates are provided of total emissions of oxides of sulfur, particulates, carbon monoxide, hydrocarbons and oxides of nitrogen. The emissions of these pollutants are delineated with respect to source type, season of the year; as well as their geographical distribution within the area. The study area was made up of one Standard Metropolitan Statistical Area which covers 3,080 square miles and included a 1967 population of over one million people. An estimated 1,142,000 tons of the five major pollutants are emitted annually in the Study Area. Breakdowns of this total with respect to specific pollutants are tabulated for these sources: transportation (gasoline, diesel, evaporation, aircraft); stationary fuel combustion (industry, steam-electric, residential); commercial and institutional; solid waste; and industrial process.

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Air pollution	Seasonal variations	Commerce
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Exhaust emissions	Gasoline	
Inventories	Diesel engines	
Environmental surveys	Evaporation	
Sulfur oxides	Aircraft	
Particles	Fuels	
Carbon monoxide	Industrial wastes	
Hydrocarbons	Steam electric power generation	
Nitrogen oxides	Residential buildings	

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METROPOLITAN INDIANAPOLIS

AIR POLLUTANT

EMISSION INVENTORY

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

Consumer Protection and Environmental Health Service

National Air Pollution Control Administration

Division of Air Quality and Emission Data

Durham, North Carolina

December, 1968

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2. Indiana State Air Pollution Control Board.

TABLE OF CONTENTS

	Page
Preface	1
Introduction	3
Summary of Emissions	4
Study Area	7
Coordinate System	11
Discussion of Results	13
Fuel Combustion by Stationary Sources	13
Transportation	24
Refuse Disposal	30
Industrial Process Losses	30
Point Source Emissions	30
Methodology	34
Fuel Consumption by Stationary Sources	34
Transportation	35
Refuse Disposal	35
Industrial Process Losses	36
Emissions by Grid	38

TABLE OF CONTENTS

(CONTINUED)

	Page
Emission Density	44
References	51
Appendix	53

FIGURES

		Page
Figure 1:	Indianapolis Study Area	8
Figure 2:	Indianapolis Grid Coordinate Map	12
Figure 3:	Location of Point Sources in The Indianapolis Study Area	37
Figure 4:	Population Density for the Study Area . . .	45
Figure 5:	Sulfur Oxide Emission Density from All Sources	46
Figure 6:	Particulate Emission Density from All Sources	47
Figure 7:	Carbon Monoxide Emission Density from All Sources	48
Figure 8:	Hydrocarbon Emission Density from All Sources Surveyed	49
Figure 9:	Nitrogen Oxide Emission Density from All Sources	50

TABLES

		Page
Table 1:	Summary of Air Pollutant Emissions in the Indianapolis Study Area	6
Table 2:	Area and Population Characteristics for the Study Area	9
Table 3:	Summary of Fuel Consumption in Stationary Sources	14
Table 4:	Summary of Fuel Consumption by Jurisdiction for Stationary Sources . . .	15
Table 5:	Sulfur and Ash Contents of Fuels Consumed in the Area	17
Table 6:	Summary of Fuel Consumption in Steam - Electric Utilities	18
Table 7:	Summary of Air Pollutant Emissions from Fuel Consumption in Stationary Sources .	19
Table 8:	Summary of Air Pollutant Emissions from Fuel Consumption in Stationary Sources .	20
Table 9:	Air Pollutant Emissions from Fuel Consumption in Stationary Sources by Jurisdiction	22
Table 10:	Vehicle Miles and Motor Fuel Consumption in the Study Area	25
Table 11:	Aircraft Operations for the Indianapolis Study Area	26
Table 12:	Summary of Air Pollutant Emissions from Motor Vehicle Sources	27

TABLES
(CONTINUED)

		Page
Table 13:	Air Pollutant Emissions from Aircraft at Weir Cook Field	29
Table 14:	Solid Waste Disposal by Jurisdiction for the Study Area	31
Table 15:	Air Pollutant Emissions from Solid Waste Disposal Practices	32
Table 16:	Summary of Point Source Emissions by Season for the Study Area	39
Table 17:	Summary of Total Emissions by Season for the Study Area	41

PREFACE

This report, which presents the emission inventory of the Indianapolis metropolitan area, is another in a series of studies outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These reports provide estimates of total emissions of oxides of sulfur, particulates, carbon monoxide, hydrocarbons and oxides of nitrogen. The emissions of these pollutants are delineated with respect to source type, season of the year; as well as their geographical distribution within the area. These surveys are also intended to determine the present level of emissions and status of their control in metropolitan areas.

The general procedure for these surveys is based on the rapid survey technique.[1] The Study Area is divided into grid zones that serve as the basis for locating sources and reporting their emissions. All sources of pollution are classified into two general groups i.e. point sources and area sources. All sources that emit large quantities of air pollutants are considered individually and located specifically within the Area. This group, which generally contains about fifty to one hundred sources, typically includes large industries,

INTRODUCTION

The information and data presented in this report were gathered in cooperation with the Indiana State Air Pollution Control Board and the Indianapolis Bureau of Air Pollution Control during a survey conducted in October, 1968. The data obtained in this study is representative of 1967 and emission estimates presented herein should be considered as describing the levels and conditions during 1967.

For the purposes of this survey, a Study Area consisting of eight counties in the Indianapolis metropolitan area was selected. The Study Area is made up of one Standard Metropolitan Statistical Area which covers 3,080 square miles and included a 1967 population of over one million people.

The Study Area was subdivided into 46 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 400 square kilometers in the outlying areas.

Although specific individual source information was obtained for over 50 sources, only the largest 29 were considered as point sources. These 29 sources are the most significant emitters in the Study Area.

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SUMMARY OF EMISSIONS

An estimated 1,142,000 tons of the five major pollutants are emitted annually in the Study Area. All major sources excluding organic solvent evaporation were included in this survey. Breakdowns of this total with respect to specific pollutants as well as the type of sources emitting these pollutants are given in Table 1 and are summarized below.

Pollutant Type:

Oxides of Sulfur:	Total Tons per year,	163,940
	Industrial Process -	3%
	Steam - electric utilities	66%
	Industry	20%
	Transportation	2%
	Other	9%
Particulates:	Total tons per year,	78,410
	Transportation	5%
	Industrial Process	13%
	Refuse	7%
	Steam - electric	57%
	Industry	10%
	Other	8

Carbon Monoxide:	Total Tons per year,	756,730
	Road vehicles	82%
	Industrial Process	13%
	Solid Waste	3%
	Other	2%
Hydrocarbons:	Total Tons per year,	74,430
	Road vehicles	91%
	Stationary fuel use	3%
	Other	6%
Nitrogen Oxides:	Total Tons per year,	68,750
	Road vehicles	39%
	Steam - Electric Utilities	27%
	Industrial Fuel use	18%
	Other	16%

Table 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN THE INDIANAPOLIS STUDY AREA, 1967 (Tons/Year)

Source	SO_X	PART.	CO	HC	NO_X
Transportation	2,280	4,360	622,510	69,340	27,340
Gasoline	1,640	2,190	616,280	43,110	23,300
Diesel	640	1,770	970	2,180	3,560
Evaporation	---	---	---	23,030	---
Aircraft	neg.	400	5,260	1,020	480
Stationary Fuel Combustion	157,160	58,870	9,560	2,470	36,240
Industry	33,090	7,750	1,450	520	12,510
Steam - Electric	107,700	44,100	460	180	18,340
Residential	9,940	3,560	4,350	1,070	2,700
Commerical and Institutional	6,430	3,460	3,300	700	2,690
Solid Waste	neg.	5,180	27,660	1,620	3,570
Industrial Process	4,500	10,000	97,000	1,000	1,600
TOTAL	163,940	78,410	756,730	74,430	68,750

STUDY AREA

As shown in Figure 1, the Study Area encompasses the city of Indianapolis and includes the following eight counties: (1) Boone, (2) Hamilton, (3) Hancock, (4) Hendrick, (5) Johnson, (6) Marion, (7) Morgan and (8) Shelby. Over 72 percent of the Study Area's 1967 population of 1,050,000 were residing in the urban area of Marion County. The 1960 and 1967 populations of each of the eight counties are presented in Table 2. Comparison of 1960 and 1967 population shows an increase of 11.4 percent as compared to an increase of 10.9 percent for the United States during the same period.

The major manufacturing industries of the Area are those concerned with the automotive industry and heavy machinery. The greatest portion of this heavy industry is located in the city of Indianapolis or in Marion County.

The Indianapolis Study Area is situated in the central part of the state and is located on mostly level or slightly rolling terrain. This situation along with the fact that precipitation is well distributed throughout the year, make the area suitable for farming.

The climate is continental, with warm summers and moderately cold winters. In the winter the wind speed averages about 12 m.p.h.

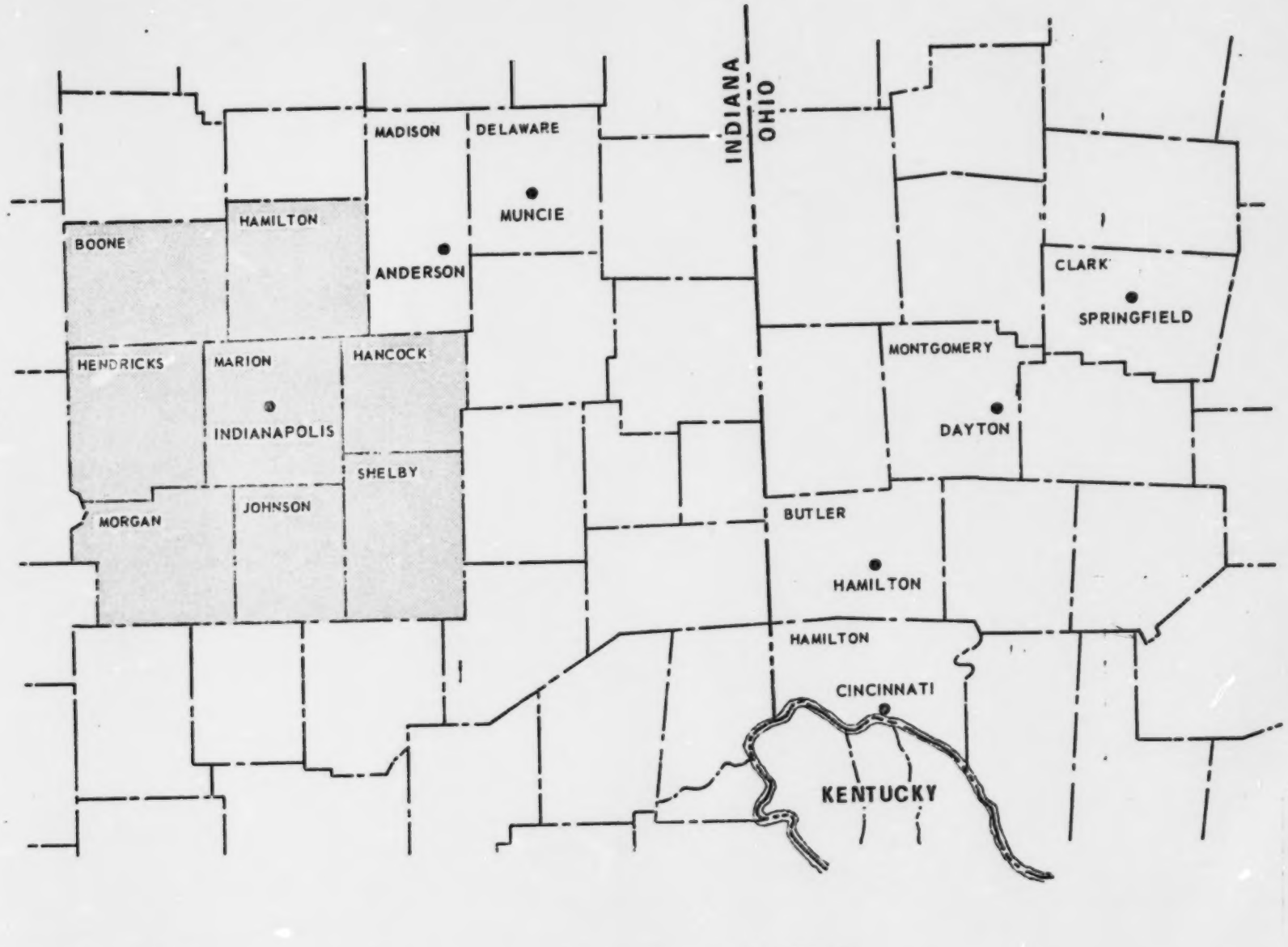


Figure 1. Indianapolis study area.

Table 2 AREA AND POPULATION CHARACTERISTICS FOR THE INDIANAPOLIS STUDY AREA, 1967

County	1967 Population	1960 Population	% inc. or decr.	Area Sq. Mi.	Pop. density Persons/Sq. Mi.
Boone	29,700	27,543	+ 7.83	427	69.6
Hamilton	47,500	40,132	+ 18.35	401	118.5
Hancock	32,800	26,665	+ 23.0	305	107.5
Hendricks	49,800	40,896	+ 21.8	417	119.4
Johnson	51,900	43,704	+ 18.8	315	164.8
Marion	762,000	697,567	+ 9.2	400	1,905.0
Morgan	41,500	33,875	+ 22.5	406	102.2
Shelby	37,200	34,093	+ 9.1	409	90.9
TOTAL	1,052,400	944,475	+ 11.4	3,080	341.7

out of the west - northwest whereas the rest of the year the prevailing wind direction is southwest at 10 m.p.h.

COORDINATE SYSTEM

Grid coordinates based on the Universal Transverse Mercator system were used in this study to show the geographical distribution of sources and emissions. As shown in Figure 2, the Study Area was divided into 46 grids of three different sizes - 25, 100, and 400 square kilometers.

Different size grids are used to limit the number of grid zones and yet allow a satisfactory definition of geographical gradation of emissions in areas where the majority of pollution occurs. For this reason the 25 square kilometer grids are used in the downtown areas, where the density of emissions would change abruptly within short distances. In areas primarily rural in nature, the use of small zones are not as important.

As illustrated in Figure 2 each grid line is identified by a coordinate number. The north - south and the east - west coordinates are expressed in meters.

The point sources are identified by both horizontal and vertical coordinates to the nearest 100 meters. The grids are identified by the coordinates of the geographical center.

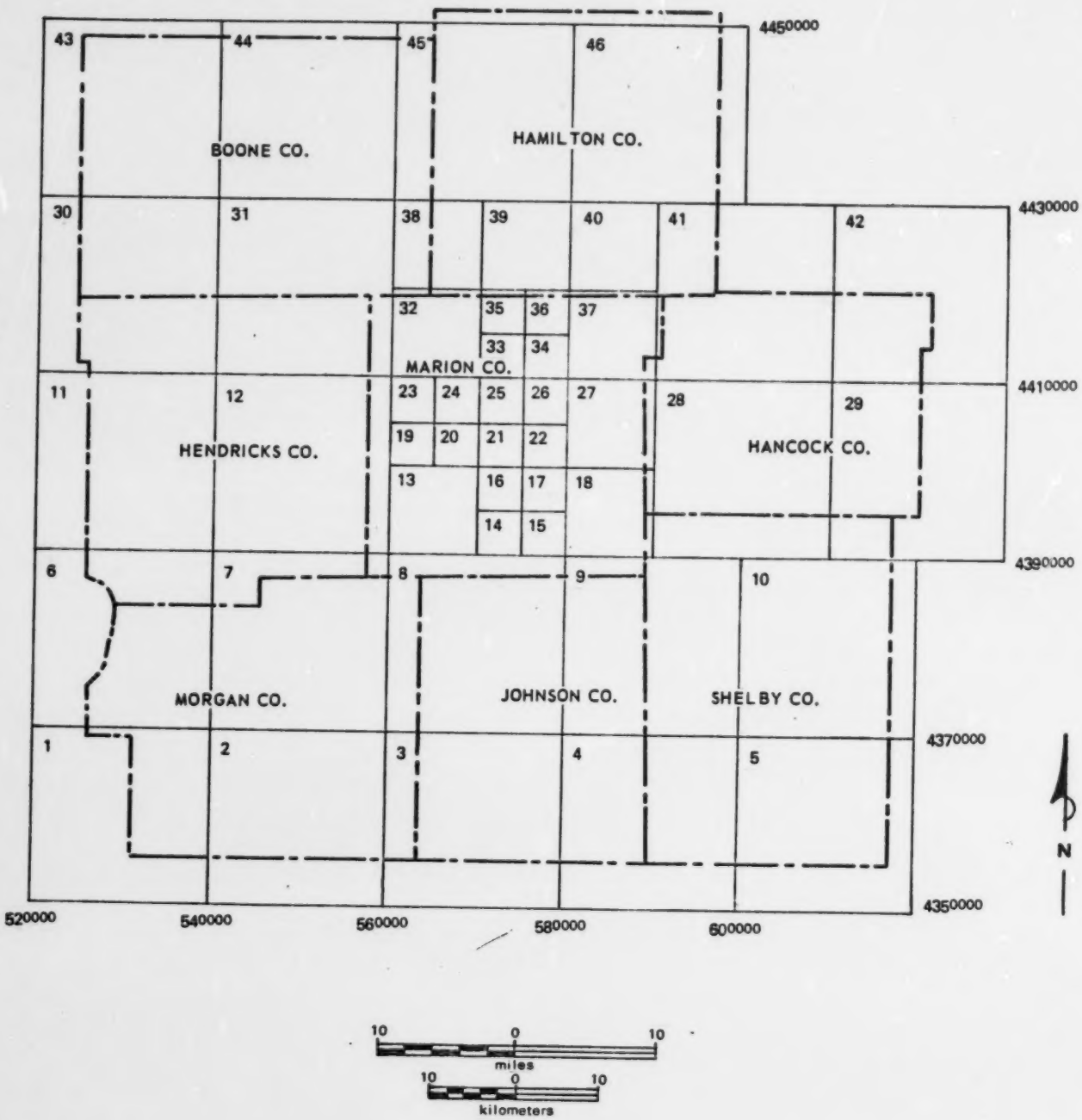


Figure 2. Indianapolis grid coordinate map.

DISCUSSION OF RESULTS

All the sources of air pollution considered in this survey fall into one of the following four categories:

1. Fuel combustion in stationary sources
2. Transportation
3. Refuse Disposal
4. Industrial process losses

Each of these categories are considered individually in this section and also in the subsequent section where data sources are given and methods of calculation are discussed.

It is important to note that the estimates presented herein and especially in the process loss category are, in most cases, partial totals. This stems from the inavailability of emission factors as well as appropriate production data. In the case of hydrocarbon emissions where gasoline evaporation was included but solvent evaporation was not, the totals are considerably lower than actual values. The results should be viewed with these limitations in mind.

Fuel Combustion by Stationary Sources

Tables 3 and 4 present the fuel consumption within the Study Area. As shown in these tables, coal is the primary fuel used in the

Table 3 SUMMARY OF FUEL CONSUMPTION IN STATIONARY SOURCES FOR THE STUDY AREA, 1967

Source	Coal 1,000's Tons	Residual Fuel Oil (10^6 gal.)	Distillate Fuel Oil (10^6 gal.)	Natural Gas 10^8 Ft.^{3}
Steam - electric	1,805	0.1	0	0
Industry	1,050	12.4	12.2	123.0
Residential	170	neg.	150.3	291.2
Commercial and Institutional	115	neg.	45.0	94.5
TOTAL	3,140	12.5	207.5	508.7

Table 4 SUMMARY OF FUEL CONSUMPTION BY JURISDICTION FOR STATIONARY SOURCES IN THE STUDY AREA, 1967

County	Distillate Fuel Oil (10^6 gal.)			Residual Fuel Oil (10^6 gal.)	Coal (1,000's -- Tons)			Natural Gas (10^8 Ft^3)		
	Res.	Ind.	C&I		Res.	Ind.[a]	C&I	Res.	Ind.	C&I
Boone	4.9	0.2	1.5	0.2	8	neg.	neg.	6.5	1.8	1.9
Hamilton	9.2	0.3	2.0	0.4	11	65	neg.	6.5	3.0	2.2
Hancock	3.9	0.1	0.5	0.1	7	neg.	neg.	7.4	1.3	1.4
Hendricks	8.3	neg.	1.0	neg.	8	neg.	neg.	7.3	0.3	1.7
Johnson	7.5	0.2	0.5	0.3	8	10	neg.	8.7	2.8	2.3
Marion	106.0	11.0	34.0	11.0	107	1,920	115	241.5	109.0	80.0
Morgan	5.1	0.1	2.0	0.1	12	870	neg.	6.4	1.1	1.6
Shelby	5.4	0.3	3.5	0.4	9	neg.	neg.	6.9	3.7	3.4
TOTAL	150.3	12.2	45.0	12.5	170	2,855	115	291.2	123.0	94.5

a. includes steam - electric power plants

b. neg = negligible

Res = Residential

Ind = Industrial

C&I = Commercial and Institutional

area. During 1967, about 220 million gallons of oil, 51 billion cubic feet of gas and 3,140 thousand tons of coal were burned within the Study Area. In terms of the total energy supplied, coal accounted for 49 percent, fuel oil 20 percent and natural gas 31 percent. The average physical characteristics[3,4] of the fuels are summarized in Table 5.

The industries and steam - electric utilities are the largest fuel users in the Area. During 1967, they consumed more than 90 percent of the coal and 25 percent of the natural gas.

The fuel consumption by steam - electric utilities is presented in Table 6. This also shows the type of control equipment and estimated efficiencies.[5] Since most of the control equipment is old, the efficiencies are low.

Natural gas and fuel oil are of about equal importance as fuels to provide heat for homes and apartments. As shown in Table 7 about 44% of the units use gas and 49% were heated by distillate fuel oil. The use of coal is significant but its use is declining. Since 1960 the number of dwelling units burning coal has decreased by almost two thirds.[6] The number of homes heated by fuel oil has remained just about constant over the same period.

The emissions resulting from the burning of these fuels are summarized in Table 8 and by jurisdiction in Table 9. The use of fuels is the largest source of sulfur oxides in the Area accounting

Table 5 SULFUR AND ASH CONTENTS OF FUELS CONSUMED IN THE INDIANAPOLIS STUDY AREA, 1967

Fuel	% Sulfur	% Ash
Coal		
Commercial and Retail	1.0 - 2.2	5.8 - 6.8
Industrial	1.4 - 3.4	6.2 - 8.0
Electric Utility	1.8 - 3.5	7.6 - 8.6
Metallurgical	0.8	4.5
Residual Fuel Oil	1.7	---
Distillate Fuel Oil	0.28	---
Natural Gas	0.0008	---

Table 6 SUMMARY OF FUEL CONSUMPTION IN STEAM - ELECTRIC POWER PLANTS IN THE STUDY AREA, 1967.

Plant	Coal 1,000's Tons	Fuel Oil 1,000's gal.	Natural Gas 10^6 Ft^3	Controls	Overc Estimat Efficie
E. W. Stout	820	0	0	ESP and Mechanical	60
Perry K & W	50	0	0	Mechanical	50
H. T. Prichard	870	0	0	ESP and Mechanical	70
Noblesville	65	130	0	Mechanical	60
TOTAL	1,805	130	0		

a. ESP - Electrostatic Precipitator

b. Mechanical - Mechanical collectors; consists of cyclone collectors or baffles, separately or in combination.

Table 7 SUMMARY OF DOMESTIC HEATING UNITS BY FUEL TYPE FOR THE STUDY AREA 1967

County	Total Units	Coal	Oil	Gas
Boone	9,140	1,100	4,200	3,840
Hamilton	13,250	1,500	7,900	3,850
Hancock	8,970	1,000	3,450	4,520
Hendricks	13,320	1,200	7,540	4,580
Johnson	13,700	1,200	6,950	5,550
Marion	215,110	17,000	103,200	94,910
Morgan	10,600	1,700	4,770	4,130
Shelby	10,440	1,200	4,920	4,320
TOTAL	294,530	23,300	142,930	128,300

Table 8 SUMMARY OF AIR POLLUTANT EMISSIONS FROM FUEL CONSUMPTION IN STATIONARY SOURCES FOR THE STUDY AREA, 1967 (Tons/Year)

Source	SO_X	Part.	CO	HC	NO_X
Industry					
Coal	31,150	7,410	1,430	500	10,200
Fuel Oil	1,940	230	20	20	990
Natural Gas	neg.	110	neg.	neg.	1,320
TOTAL	33,090	7,750	1,450	520	12,510
Residential					
Coal	6,580	2,770	4,190	840	670
Fuel Oil	3,350	600	150	230	910
Natural Gas	10	190	10	neg.	1,120
TOTAL	9,940	3,560	4,350	1,070	2,700
Commercial and Institutional					
Coal	5,440	3,030	3,250	650	520
Fuel Oil	990	340	50	50	1,620
Natural Gas	neg.	90	neg.	neg.	550
TOTAL	6,430	3,460	3,300	700	2,690

Table 8 SUMMARY OF AIR POLLUTANT EMISSIONS FROM FUEL CONSUMPTION IN STATIONARY SOURCES FOR THE STUDY AREA, 1967 (Tons/Year)

(CONTINUED)

Source	SO_X	Part.	CO	HC	NO_X
Steam-Electric					
Coal	107,700	44,100	460	180	18,340
Fuel Oil	neg.	neg.	neg.	neg.	neg.
Natural Gas	0	0	0	0	0
Total	107,700	44,100	460	180	18,340
TOTAL					
Coal	150,870	57,310	9,330	2,170	29,730
Fuel Oil	6,280	1,170	220	300	3,520
Natural Gas	10	390	10	neg.	2,990
Total	157,160	58,870	9,560	2,470	36,240

TABLE 10 VEHICLE MILES AND MOTOR FUEL CONSUMPTION IN THE STUDY AREA, 1967

County	Gasoline 1000's gal./year	Diesel 1000's gal./year	Total vehicle Miles 1000's/day
Boone	11,000	940	380
Hamilton	20,620	1,760	720
Hancock	11,770	1,000	410
Hendricks	15,980	1,360	560
Johnson	26,050	2,220	910
Marion	331,700	28,240	11,550
Morgan	14,020	1,200	490
Shelby	12,660	1,080	440
Total	443,800	37,800	15,460

TABLE 11 AIRCRAFT OPERATIONS AT
WEIR-COOK FIELD, 1967

Itinerant	Operation/Year
Air Carrier	80,631
General	87,487
Military	2,468
Total	170,588
Local	
General	44,858
Military	4,479
Total	49,337
Total	219,923
Total Air Carrier	80,631
Total General	132,345
Total Military	6,947
Total	219,923

TABLE 12 SUMMARY OF AIR POLLUTANT EMISSIONS FROM MOTOR VEHICLE SOURCES IN THE STUDY AREA, 1967 (TONS/YEAR)

COUNTY	SOURCE	SO	PART.	CO	HC	NOX
Boone	gasoline	40	50	8,980	710	570
	Diesel	20	50	20	50	90
	Evaporation	--	--	--	570	--
	Total	60	100	9,000	1,330	660
Hamilton	Gasoline	80	100	18,440	1,430	1,090
	Diesel	30	80	60	100	160
	Evaporation	--	--	--	1,070	--
	Total	110	180	18,500	2,600	1,250
Hancock	Gasoline	40	60	11,600	890	620
	Diesel	20	50	30	60	100
	Evaporation	--	--	--	600	--
	Total	60	110	11,630	1,550	720
Hendricks	Gasoline	60	80	15,280	1,170	840
	Diesel	20	60	40	80	130
	Evaopration	--	--	--	830	--
	Total	80	140	15,320	2,080	970
Johnson	Gasoline	90	130	25,140	1,920	1,360
	Diesel	40	100	60	130	210
	Evaopration	--	--	--	1,350	--
	Total	130	230	25,200	3,400	1,570

TABLE 12 SUMMARY OF AIR POLLUTANT EMISSIONS FROM MOTOR VEHICLE SOURCES IN THE STUDY AREA, 1967 (TONS/YEAR)

COUNTY	SOURCE	SO_x	PART.	CO	HC	NO_x
Marion	Gasoline	1,230	1,640	512,800	35,170	17,400
	Diesel	470	1,320	700	1,630	2,660
	Evaopration	--	--	--	17,200	--
	Total	1,700	2,960	513,500	54,000	20,060
Morgan	Gasoline	50	70	12,570	960	750
	Diesel	20	60	30	70	110
	Evaopration	--	--	--	730	--
	Total	70	130	12,600	1,760	860
Shelby	Gasoline	50	60	11,500	1,600	770
	Diesel	20	50	30	60	100
	Evaporation	--	--	--	660	--
	Total	70	110	11,500	1,600	770
Total	Gasoline	1,640	2,190	616,280	43,110	23,300
Study	Diesel	640	1,770	970	2,180	3,560
Area	Evaopration	--	--	--	23,030	--
	Total	2,280	3,960	617,250	68,320	26,860

*-- = Not applicable

TABLE 13 AIR POLLUTANT EMISSIONS FROM AIRCRAFT AT WEIR COOK FIELD, 1967 (TONS-YEAR)

Type of Operation	SO_x	PART.	CO	HC	NO_x
Air Carrier	Neg.	325	1,000	200	250
General Aviation	Neg.	70	4,050	760	220
Military	Neg.	5	210	40	10
Total	Neg.	400	5,260	1.020	480

source of pollution. In 1967, they accounted for 99 percent of the carbon monoxide, 98 percent of the hydrocarbons, 98 percent of the oxides of nitrogen, 91 percent of the particulates and 100 percent of the sulfur oxides (of the total transportation emissions). Diesel fuel powered vehicles were an important source of hydrocarbons and oxides of nitrogen.

The emissions from aircraft, although small, may be significant in that they occur at one location rather than throughout the area as is the case for motor vehicles.

Refuse Disposal

The estimated tonnages of refuse disposal is summarized in Table 14. Nearly all of the refuse is disposed of by open or on site burning. However, after January 1, 1968, there was a ban on open burning and it is hoped that a municipal incinerator will be in operation later in the year. The estimates were determined by applying a percapita generation rate of 4.5 lb. per day.[8] These are rough estimates and should be considered as such.

The emissions from refuse burning are summarized in Table 15.

Industrial Process Losses.

Emissions in this category were found by applying emission factors to production rate data for the various industries. The emissions are presented in Table 1.

Point Source Emissions.

Total point source emissions which included both fuel burning and process information are presented in Table 16. Point sources

TABLE 14 SOLID WASTE DISPOSAL BY JURISDICTION FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/YEAR)

COUNTY	1967 Population	Refuse Generated[a]	Amount Burned[b]	Non-combustibles
Boone	29,700	24,390	18,290	6,100
Hamilton	47,500	39,000	29,250	9,750
Hancock	32,800	26,940	20,210	6,730
Hendricks	49,800	40,900	30,680	10,220
Johnson	51,900	42,620	31,960	10,660
Marion	762,000	625,750	469,300	156,450
Morgan	41,500	34,080	25,560	8,520
Shelby	37,200	30,550	22,910	7,640
Total	1,052,400	864,230	648,160	216,070

*a=Refuse generated at the rate of 4.5 lb. per person per day

b= on-site incineration or open burning

TABLE 15 AIR POLLUTANT EMISSIONS BY JURISDICTION FROM SOLID WASTE DISPOSAL FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/YEAR)

COUNTY	SO_x	PART.	CO	HC	NO_x
Boone	0	145	780	45	100
Hamilton	0	235	1,270	75	160
Hancock	0	160	860	50	110
Hendricks	0	245	1,300	75	170
Johnson	0	255	1,380	80	175
Marion	0	3,760	20,000	1,170	2,590
Morgan	0	200	1,100	65	140
Shelby	0	180	970	60	125
Total	0	5,180	27,660	1,620	3,570

collectively accounted for the following percentages of the total pollutants:

Sulfur Oxides:	90%
Particulates:	81%
Carbon Monoxide:	14%
Hydorcarbons:	4%
Nitrogen Oxides:	49%

METHODOLOGY

The following discussion is a summary of procedures used in the Indianapolis emission inventory.

Fuel Consumption by Stationary Sources

The local air pollution agencies were contacted as to the use of fuels in the major industrial, commercial and institutional establishments under their jurisdiction. The large industrial facilities and steam electric utilities consumed 91 percent of the coal but only 11 percent of the oil and 24 percent of the gas. On the basis of this information 95 percent of the coal and 10 percent of the residual fuel oil burned in the area was accounted for by point sources. The balance of the fuel was distributed to the three area source categories of fuel consumption: (1) residential, (2) commercial - institutional (this includes federal facilities) and (3) industrial.

The amount of fuel burned for home heating purposes was calculated using the procedure described in the Rapid Survey Technique. The method includes such variables, as total annual degree days, average number of rooms per dwelling unit, and the number of units using each type of fuel. It was assumed that all fuel oil burned for residential use was distillate.

Commercial - institutional fuel consumption figures were not available except in the case of natural gas usage in Marion County. Fuel oil was determined by substracting residential fuel oil from

county totals of residential and commercial sales supplied by the Fuel Oil Institute. Institutional coal usage was found by subtracting residential coal usage from the retail coal usage figures supplied by a local coal company.

Transportation

Emissions from this category were found by the application of two different method depending on the type of information available.

In Marion County vehicle mile data were available through a Transportation Study done in 1964.[9] These vehicle miles of travel were apportioned to the grid system by means of traffic flow maps which were supplied by the Transportation Agency.

The vehicle miles were updated to 1967 and adjusted to account for the fact that not all secondary roads were included. It was estimated that the Transportation study accounted for 85% of the total vehicle miles.

In the other seven counties, vehicle mile information was not available and thus gasoline consumption[10] was used to find vehicular emissions. The gasoline consumed in each county was apportioned on a grid basis by population.

Emissions from diesel powered vehicles were determined by diesel fuel consumption in each county.[11] These emissions were apportioned on a grid basis by assuming they were proportional to gasoline emissions.

Refuse Disposal

Emissions in this category were determined by assuming a percapita generation rate of 4.5 pounds of refuse per day. By personal contact with

local agencies it was found that no large incinerators or large open burning dumps were in operation in the Area. Thus all disposal was assumed to be on-site incineration or open burning and emissions were apportioned on a grid bases by population.

Industrial Process

The various industries in the Area were contacted as to their fuel use and production rates. From this information, industrial process losses were determined for processes where emission factors were available. The totals in this category are by no means complete since time did not permit a thorough contacting of all industry in the Area. However, information on most of the major industries was available and this should represent a large percentage of the total in this category.

The following is a brief description of the number and types of industry contacted. All the large foundries in the Area supplied production data. Of these six foundries, which ranged in size from 200 to 250,000 tons per year, only two had any air pollution control equipment. Four concrete or asphalt batching plants were surveyed, of which only one had control equipment. There was one glass manufacturing plant and one oil refinery which was not equipped with a waste heat boiler. In addition several grain handling and storage elevators were contacted. However emissions from these facilities were not significant.

Figure 3 shows the location of the major point source emitters in the Study Area.

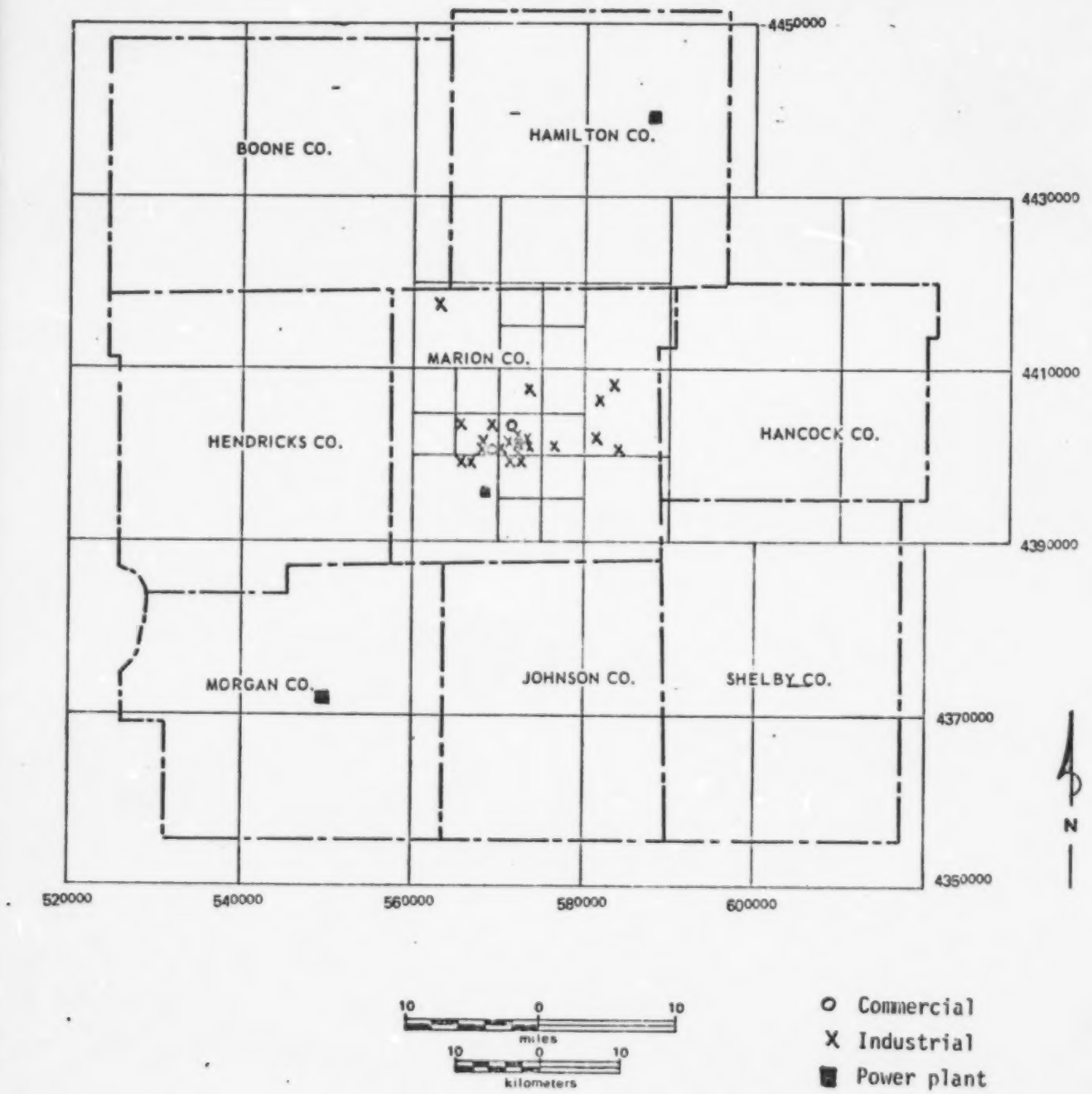


Figure 3 Location of Point Sources

Emissions by Grid

Table 17 presents the total emissions from all sources for each of the 46 grids in the Indianapolis Study Area. The previous sections of the report describe how each category was apportioned by grid. These subtotals were added to the point sources to arrive at the total emissions per day. The Appendix describes the procedure for the calculation of the annual as well as the summer and winter emission averages for a point source. However, the same procedure, with some modifications for transportation, is used for area sources as well.

TABLE 16 SUMMARY OF POINT SOURCE EMISSIONS BY SEASON FOR THE INDIANAPOLIS S

Category	Horizontal-Vertical Coordinates		SO_x S	SO_x W	SO_x A	PART. S	PART. W	PART. A	CO S	CO W
Power Plant	55000	43710	126.81	126.81	126.81	49.20	49.20	49.20	0.60	0.60
Power Plant	56900	43960	149.40	149.40	149.40	61.11	61.11	61.11	0.56	0.56
Industrial	56730	43990	1.64	2.26	1.93	0.57	0.79	0.68	0.04	0.06
Industrial	56650	43990	2.50	3.71	3.12	0.88	1.30	1.09	0.07	0.10
Industrial	57280	43990	3.77	5.22	4.43	1.32	1.83	1.56	0.10	0.14
Industrial	57050	43993	0.41	3.17	2.04	0.14	1.11	0.71	0.01	0.08
Industrial	56700	44003	21.53	28.45	25.33	2.62	3.14	2.90	87.72	88.41
Industrial	56510	44035	3.31	4.37	3.89	0.69	0.91	0.81	0.09	0.11
Industrial	56850	44015	1.00	1.38	1.25	0.35	0.49	0.44	0.03	0.04
Commercial	56970	44033	5.73	18.41	11.45	2.33	7.49	4.66	3.42	11.07
Industrial	56950	44015	2.28	3.32	2.85	0.80	1.16	1.00	0.06	0.09
Industrial	57350	44018	--	--	--	0.07	0.07	0.07	1.03	1.03
Commercial	57100	44035	1.75	5.52	3.44	1.82	5.84	3.63	1.03	3.30
Power Plant	57100	44024	9.30	9.30	9.30	4.75	4.75	4.75	0.04	0.04
Industrial	57250	44011	1.90	5.36	3.80	0.43	1.22	0.87	0.05	0.14
Industrial	57060	44013	1.90	5.36	3.80	0.33	0.94	0.67	0.05	0.14
Industrial	57100	44003	0.68	1.51	1.14	0.24	0.53	0.40	0.02	0.04
Industrial	57300	44016	2.14	3.61	2.85	0.67	1.14	0.90	0.06	0.09
Industrial	57140	44010	0.13	0.18	0.16	0.04	0.06	0.05	0.01	0.01
Industrial	57640	44030	1.90	5.36	3.80	0.40	1.13	0.80	0.05	0.14
Industrial	57380	44068	--	--	--	0.51	0.51	0.51	--	--

A

OURCE EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/DAY)

PART.			CO			HC			NO_x		
A	S	W	A	S	W	A	S	W	A	S	W	A
126.81	49.20	49.20	49.20	0.60	0.60	0.60	0.24	0.24	0.24	23.84	23.84	23.84
149.40	61.11	61.11	61.11	0.56	0.56	0.56	0.23	0.23	0.23	22.47	22.47	22.47
1.93	0.57	0.79	0.68	0.04	0.06	0.05	0.01	0.02	0.02	0.29	0.40	0.34
3.12	0.88	1.30	1.09	0.07	0.10	0.08	0.02	0.03	0.03	0.44	0.65	0.55
4.43	1.32	1.83	1.56	0.10	0.14	0.12	0.03	0.05	0.04	0.66	0.92	0.78
2.04	0.14	1.11	0.71	0.01	0.08	0.05	0.00	0.03	0.02	0.07	0.56	0.36
25.33	2.62	3.14	2.90	87.72	88.41	88.10	0.71	0.94	0.83	14.17	18.72	16.67
3.89	0.69	0.91	0.81	0.09	0.11	0.10	0.03	0.04	0.03	0.59	0.78	0.69
1.25	0.35	0.49	0.44	0.03	0.04	0.03	0.01	0.01	0.01	0.18	0.24	0.22
11.45	2.33	7.49	4.66	3.42	11.07	6.85	0.68	2.20	1.37	0.55	1.76	1.10
2.85	0.80	1.16	1.00	0.06	0.09	0.07	0.02	0.03	0.03	0.40	0.58	0.50
--	0.07	0.07	0.07	1.03	1.03	1.03	--	--	--	--	--	--
3.44	1.82	5.84	3.63	1.03	3.30	2.05	0.21	0.66	0.41	0.16	0.53	0.33
9.30	4.75	4.75	4.75	0.04	0.04	0.04	0.01	0.01	0.01	1.40	1.40	1.40
3.80	0.43	1.22	0.87	0.05	0.14	0.02	0.05	0.03	0.03	0.33	0.94	0.67
3.80	0.33	0.94	0.67	0.05	0.14	0.10	0.02	0.05	0.03	0.33	0.94	0.67
1.14	0.24	0.53	0.40	0.02	0.04	0.03	0.01	0.01	0.01	0.12	0.27	0.20
2.85	0.67	1.14	0.90	0.06	0.09	0.07	0.02	0.03	0.03	0.38	0.63	0.50
0.16	0.04	0.06	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.21	0.28	0.25
3.80	0.40	1.13	0.80	0.05	0.14	0.10	0.02	0.05	0.03	0.33	0.94	0.67
--	0.51	0.51	0.51	--	--	--	--	--	--	--	--	--

B

TABLE 16 SUMMARY OF POINT SOURCE EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUD

Category	Horizontal-Vertical Coordinates		SO_x			PART.			CO		
			S	W	A	S	W	A	S	W	A
Industrial	57680	44020	1.52	2.14	1.90	0.53	0.75	0.67	0.04	0.06	0.0
Industrial	58200	44063	4.25	5.25	4.72	1.49	1.84	1.66	0.11	0.14	0.1
Industrial	58150	44015	4.97	8.84	7.09	1.60	2.85	2.28	0.11	0.20	0.1
Industrial	58400	44003	0.76	6.30	3.80	0.27	2.21	1.33	0.02	0.17	1.1
Industrial	58150	44070	1.52	5.67	3.80	0.53	1.99	1.33	0.04	0.15	0.1
Industrial	56430	44185	12.50	12.50	12.50	0.14	0.14	0.14	171.30	171.30	171.3
Power Plant	58780	44390	6.87	6.87	9.51	4.05	4.05	5.60	0.05	0.05	0.0

A

CE EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/DAY)

	PART.			CO			HC			NO_x		
A	S	W	A	S	W	A	S	W	A	S	W	A
.90	0.53	0.75	0.67	0.04	0.06	0.05	0.01	0.02	0.01	0.27	0.38	0.33
.72	1.49	1.84	1.66	0.11	0.14	0.12	0.04	0.05	0.04	0.75	0.92	0.83
.09	1.60	2.85	2.28	0.11	0.20	0.16	0.04	0.07	0.05	0.90	1.60	1.28
.80	0.27	2.21	1.33	0.02	0.17	1.10	0.01	0.06	0.03	0.13	1.10	0.67
.80	0.53	1.99	1.33	0.04	0.15	0.10	0.01	0.05	0.03	0.27	0.99	0.67
.50	0.14	0.14	0.14	171.30	171.30	171.30	2.75	2.75	2.75	4.38	4.38	4.38
.51	4.05	4.05	5.60	0.05	0.05	0.06	0.02	0.02	0.03	1.82	1.82	2.53

B

TABLE 17 SUMMARY OF TOTAL EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AREA

Grid	Area KM^2	SO_x S	SO_x W	SO_x A	PART. S	PART. W	PART. A	CO S	CO W	CO A
1	400	0.00	0.18	0.11	0.03	0.10	0.07	1.41	1.25	1.35
2	400	0.11	1.40	0.69	25.40	25.87	25.62	15.76	12.85	15.15
3	400	0.08	0.61	0.32	0.25	0.43	0.34	11.45	9.02	10.88
4	400	0.06	0.42	0.22	0.18	0.29	0.24	8.54	6.70	8.11
5	400	0.01	0.26	0.19	0.05	0.14	0.11	1.93	1.56	1.85
6	400	0.04	0.47	0.24	0.14	0.30	0.22	5.76	4.65	5.42
7	400	128.69	129.93	127.52	50.72	50.72	57.82	22.43	17.93	21.42
8	400	0.28	1.09	1.11	1.15	1.65	1.40	54.00	42.02	51.03
9	400	0.17	1.25	0.67	0.57	0.80	0.73	32.03	24.88	30.27
10	400	0.16	1.98	1.05	0.62	1.26	0.94	26.23	21.04	25.06
11	400	0.04	0.46	0.25	0.13	0.27	0.20	5.26	4.21	5.02
12	400	0.33	2.20	1.22	1.04	1.57	1.32	59.59	47.51	58.08
13	100	155.96	159.61	155.64	64.46	65.62	64.19	68.77	52.28	65.86
14	25	0.17	0.55	0.35	0.39	0.47	0.44	33.19	25.15	31.15
15	25	0.03	0.54	0.26	0.17	0.34	0.25	6.39	5.17	6.10
16	25	4.48	10.89	7.78	2.50	4.65	3.64	67.78	52.54	64.03
17	25	0.18	1.72	0.88	0.68	1.16	0.91	39.70	30.88	37.54
18	100	0.20	0.86	0.50	0.51	0.67	0.60	39.31	30.13	36.94
19	25	0.19	1.82	1.43	0.50	0.95	0.87	44.38	33.80	41.72
20	25	34.20	59.44	47.07	7.91	15.24	11.52	189.08	174.55	187.17

A

EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/DAY)

PART. W	A	S	CO W	A	S	HC W	A	S	NO_x W	A
0.10	0.07	1.41	1.25	1.35	0.19	0.16	0.19	0.11	0.21	0.21
25.87	25.62	15.76	12.85	15.15	2.27	1.89	2.21	1.28	1.28	1.34
0.43	0.34	11.45	9.02	10.88	1.67	1.33	1.59	0.92	0.85	0.93
0.29	0.24	8.54	6.70	8.11	1.25	0.99	1.19	0.68	0.63	0.68
0.14	0.11	1.93	1.56	1.85	0.27	0.23	0.27	0.15	0.34	0.34
0.30	0.22	5.76	4.65	5.42	0.83	0.68	0.80	0.46	0.46	0.49
50.72	57.82	22.43	17.93	21.42	2.99	2.46	2.89	25.54	25.61	25.36
1.65	1.40	54.00	42.02	51.03	6.75	5.30	6.41	3.46	3.37	3.57
0.80	0.73	32.03	24.88	30.27	4.05	3.18	3.85	2.01	1.87	2.03
1.26	0.94	26.23	21.04	25.06	3.54	2.90	3.42	1.91	2.10	2.17
0.27	0.20	5.26	4.21	5.02	0.76	0.61	0.73	0.42	0.48	0.51
1.57	1.32	59.59	47.51	58.08	7.81	6.08	7.40	3.83	3.56	4.92
65.62	64.19	68.77	52.28	65.86	8.93	7.00	8.47	27.70	27.52	27.51
0.47	0.44	33.19	25.15	31.15	4.27	3.26	4.01	1.99	1.60	1.90
0.34	0.25	6.39	5.17	6.10	0.78	0.64	0.75	0.43	0.46	0.46
4.65	3.64	67.78	52.54	64.03	7.84	6.11	7.48	4.30	4.82	4.77
1.16	0.91	39.70	30.88	37.54	4.57	3.61	4.36	2.13	2.07	2.19
0.67	0.60	39.31	30.13	36.94	5.05	3.86	4.75	2.37	1.97	2.30
0.95	0.87	44.38	33.80	41.72	5.18	3.98	4.90	2.26	2.87	3.17
15.24	11.52	189.08	174.55	187.17	11.60	11.11	9.90	19.98	26.85	24.30

B

TABLE 17 SUMMARY OF TOTAL EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AR

Grid	Area KM^2	SOx S	SOx W	SOx A	PART. S	PART. W	PART. A	CO S	CO W	CO A
21	25	18.58	36.66	27.94	10.25	17.94	14.03	195.37	152.23	184.98
22	25	2.23	10.02	6.59	1.77	3.86	2.95	121.10	93.32	114.22
23	25	0.12	1.65	1.31	0.36	0.80	0.71	28.76	22.01	27.09
24	25	0.21	3.35	2.13	0.88	1.87	1.49	76.25	58.76	71.91
25	25	0.57	5.36	3.28	2.23	3.62	3.03	185.39	141.48	174.32
26	25	1.88	6.22	4.46	1.82	3.17	2.63	135.30	103.41	127.28
27	100	12.05	31.07	22.52	5.55	11.85	9,03	111.17	86.28	105.10
28	400	0.13	1.20	0.63	0.47	0.86	0.65	24.63	18.62	22.43
29	400	0.03	0.47	0.23	0.10	0.25	0.17	4.01	3.31	3.87
30	400	0.03	0.36	0.18	0.13	0.24	0.18	4.85	3.90	4.64
31	400	0.07	0.41	0.28	0.18	0.29	0.25	12.40	9.68	11.90
32	100	12.72	13.91	13.31	0.75	1.04	0.89	212.40	202.82	210.00
33	25	0.20	2.55	1.76	0.68	1.38	1.15	77.06	58.89	72.42
34	25	0.18	1.87	1.15	0.65	1.12	0.92	53.28	40.89	50.18
35	25	0.12	0.65	0,36	0.33	0.48	0.40	27.22	20.79	25.60
36	25	0.07	0.51	0.26	0.21	0.34	0.28	15.17	11.70	14.31
37	100	0.22	2.33	1.19	0.97	1.55	1.20	39.89	31.47	37.88
38	100	0.02	0.32	0,16	0.12	0.22	0.17	6.28	4.95	5.97
39	100	0.05	1.28	0.64	0.26	0.67	0.47	8.79	7.34	8.51
40	100	0.04	0.53	0.30	0.16	0.33	0.26	8.27	6.53	7.87
41	400	0.07	0.66	0.34	0.26	0.47	0.36	14.40	11.27	13.65

A

ISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/DAY)

RT.			CO			HC			NO_x	
W	A	S	W	A	S	W	A	S	W	A
7.94	14.03	195.37	152.23	184.98	17.60	14.28	16.93	9.01	11.81	11.23
3.86	2.95	121.10	93.32	114.22	10.83	8.56	10.32	4.29	5.86	5.72
0.80	0.71	28.76	22.01	27.09	3.34	2.59	3.17	1.53	2.26	2.42
1.87	1.49	76.25	58.76	71.91	6.79	5.37	6.48	2.47	3.49	3.56
3.62	3.03	185.39	141.48	174.32	16.62	12.90	15.74	5.77	6.46	6.85
3.17	2.63	135.30	103.41	127.28	12.12	9.44	11.50	4.48	5.34	5.59
1.85	9,03	111.17	86.28	105.10	12.94	10.26	12.34	7.95	11.09	10.41
0.86	0.65	24.63	18.62	22.43	2.96	2.36	2.83	1.50	1.54	1.64
0.25	0.17	4.01	3.31	3.87	0.58	0.48	0.56	0.32	0.33	0.34
0.24	0.18	4.85	3.90	4.64	0.07	0.57	0.68	0.39	0.39	0.40
0.29	0.25	12.40	9.68	11.90	1.62	1.25	1.52	0.76	0.82	0.91
1.04	0.89	212.40	202.82	210.00	7.98	6.79	7.70	8.88	6.61	6.89
1.38	1.15	77.06	58.89	72.42	6.80	5.35	6.54	2.37	3.16	3.37
1.12	0.92	53.28	40.89	50.18	5.52	4.29	5.23	2.25	2.60	2.78
0.48	0.40	27.22	20.79	25.60	3.17	2.44	2.99	1.40	1.21	1.38
0.34	0.28	15.17	11.70	14.31	1.70	1.37	1.66	0.80	0.73	0.80
1.55	1.20	39.89	31.47	37.88	4.98	4.00	4.77	2.57	2.56	2.67
0.22	0.17	6.28	4.95	5.97	0.79	0.63	0.76	0.39	0.39	0.41
0.67	0.47	8.79	7.34	8.51	1.06	0.94	1.05	0.60	0.83	0.79
0.33	0.26	8.27	6.53	7.87	1.03	0.83	0.98	0.53	0.63	0.66
0.47	0.36	14.40	11.27	13.65	1.82	1.44	1.73	0.90	0.87	0.93

B

TABLE 17 SUMMARY OF TOTAL EMISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY A

Grid	Area Km^2	SO_x S	SO_x W	SO_x A	PART. S	PART. W	PART. A	CO S	CO W	CO A
42	400	0.02	0.40	0.19	0.07	0.20	0.12	3.05	2.53	2.95
43	400	0.04	0.70	0.34	0.15	0.42	0.27	5.81	4.86	5.74
44	400	0.11	1.07	0.54	0.43	0.86	0.63	16.03	12.95	15.35
45	400	0.10	1.29	0.64	0.31	0.69	0.49	13.21	10.64	12.65
46	400	6.99	9.04	10.10	4.96	5.30	6.67	24.50	21.85	23.65

A

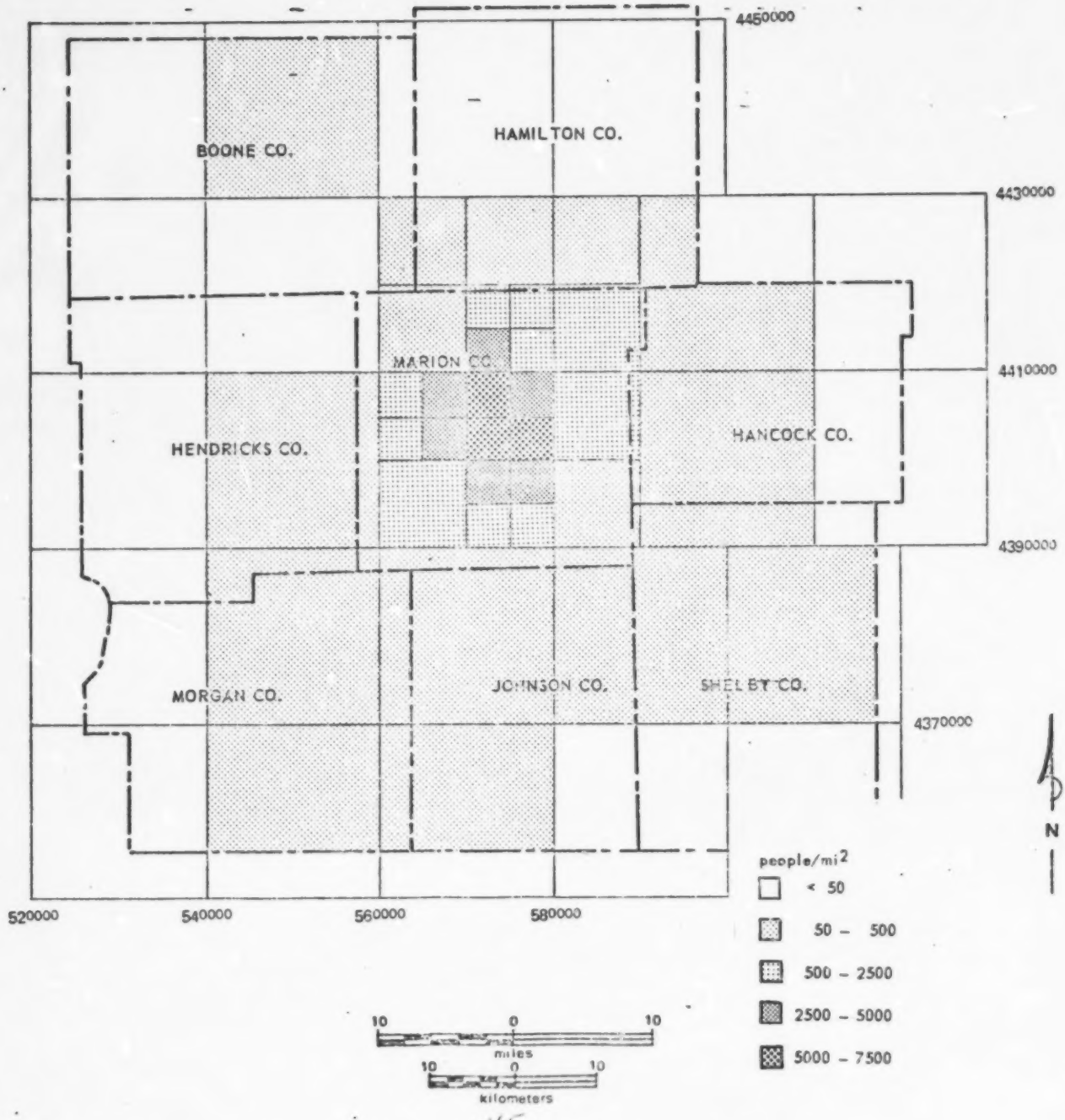
ISSIONS BY SEASON FOR THE INDIANAPOLIS STUDY AREA, 1967 (TONS/DAY)

PART.			CO			HC			NOx	
W	A	S	W	A	S	W	A	S	W	A
0.20	0.12	3.05	2.53	2.95	0.43	0.36	0.42	0.24	0.25	0.26
0.42	0.27	5.81	4.86	5.74	0.83	0.72	0.82	0.46	0.49	0.50
0.86	0.63	16.03	12.95	15.35	2.30	1.88	2.22	1.32	1.35	1.39
0.69	0.49	13.21	10.64	12.65	1.91	1.57	1.85	1.06	1.03	1.09
5.30	6.67	24.50	21.85	23.65	2.58	2.07	2.47	3.24	3.18	3.98

B

EMISSION DENSITY

Emission densities on a grid basis were obtained by dividing the total emissions in each grid by the grid area. This gives an emission density in tons of pollutant per square mile per day. Figures 5 through 9 present the results of these calculations for each of the five surveyed pollutants.



45

Figure 4. Population density for the Indianapolis study area, 1967.

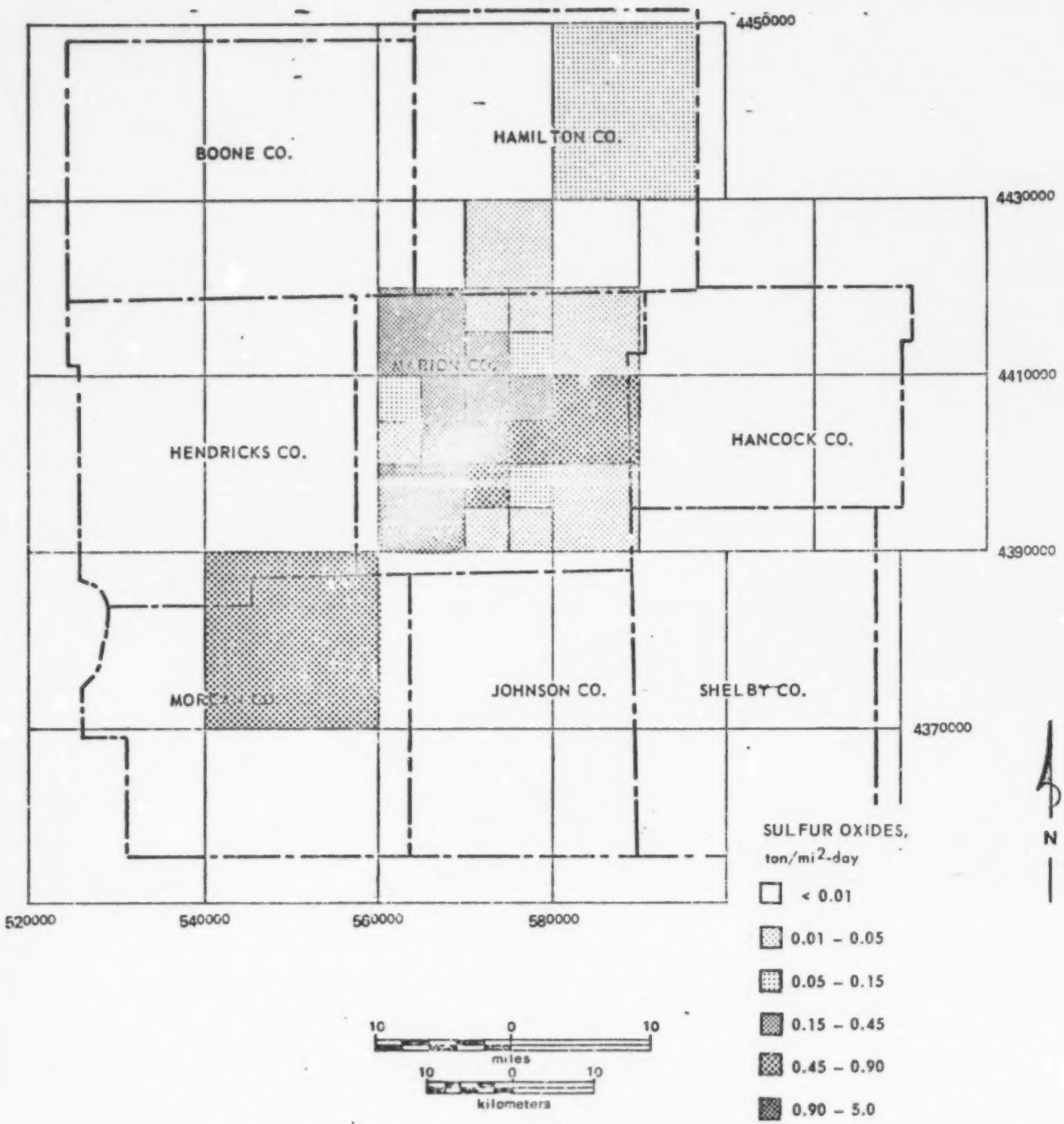


Figure 5. Sulfur oxide emission density from all sources in the Indianapolis study area, 1967.

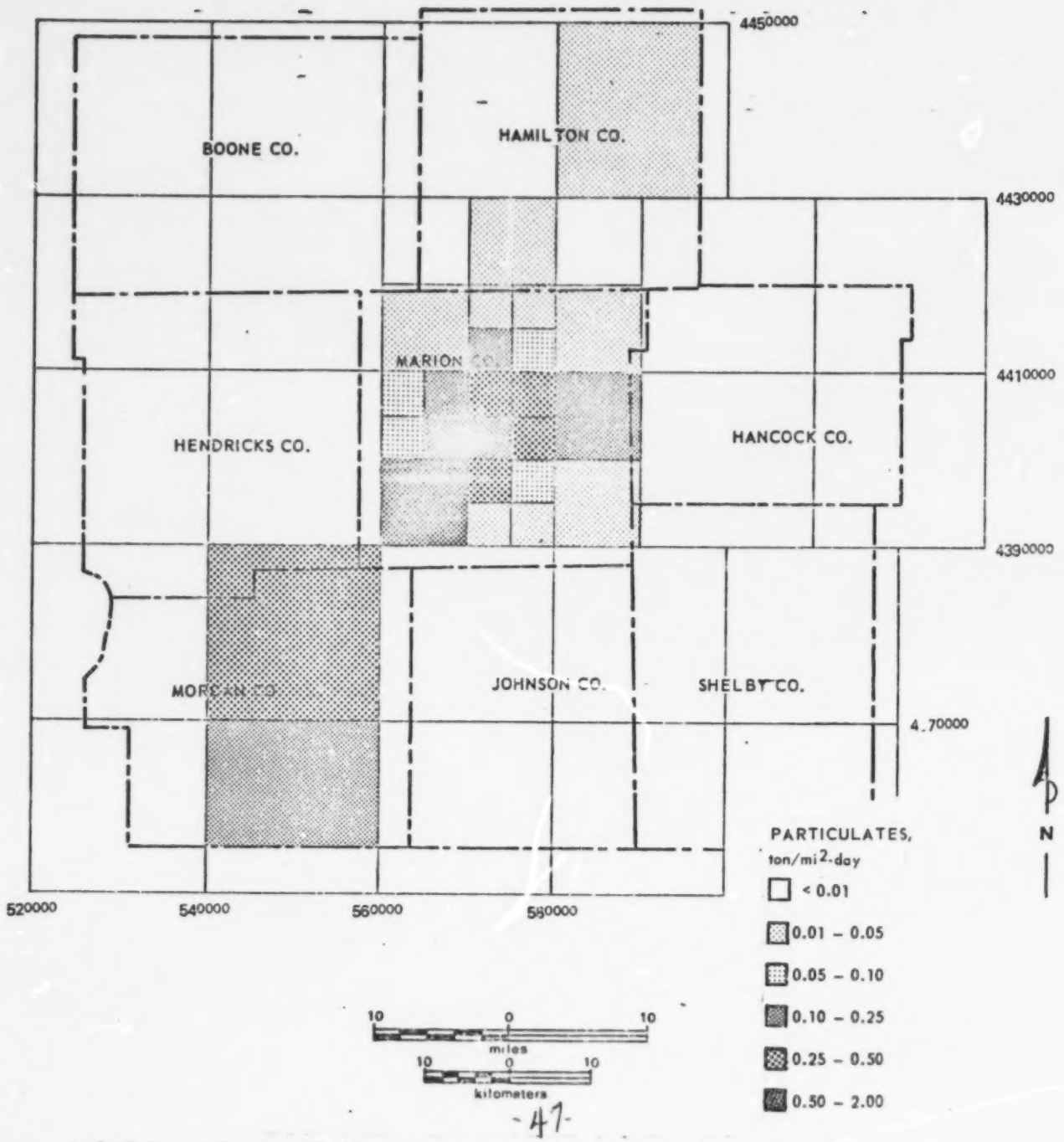


Figure 6. Particulate emission density from all sources in the Indianapolis study area, 1967.

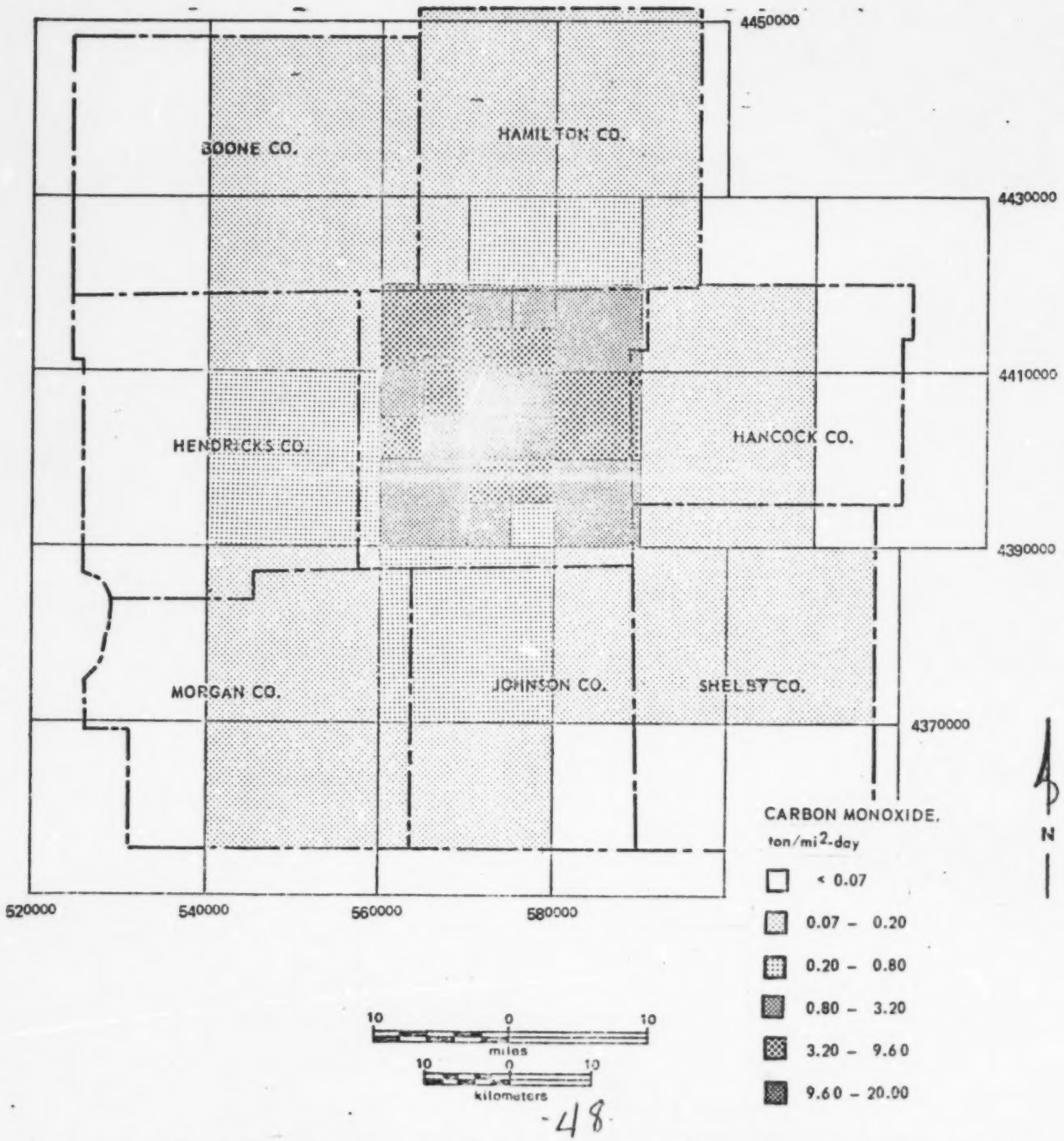


Figure 7. Carbon monoxide emission density from all sources in the Indianapolis study area, 1967.

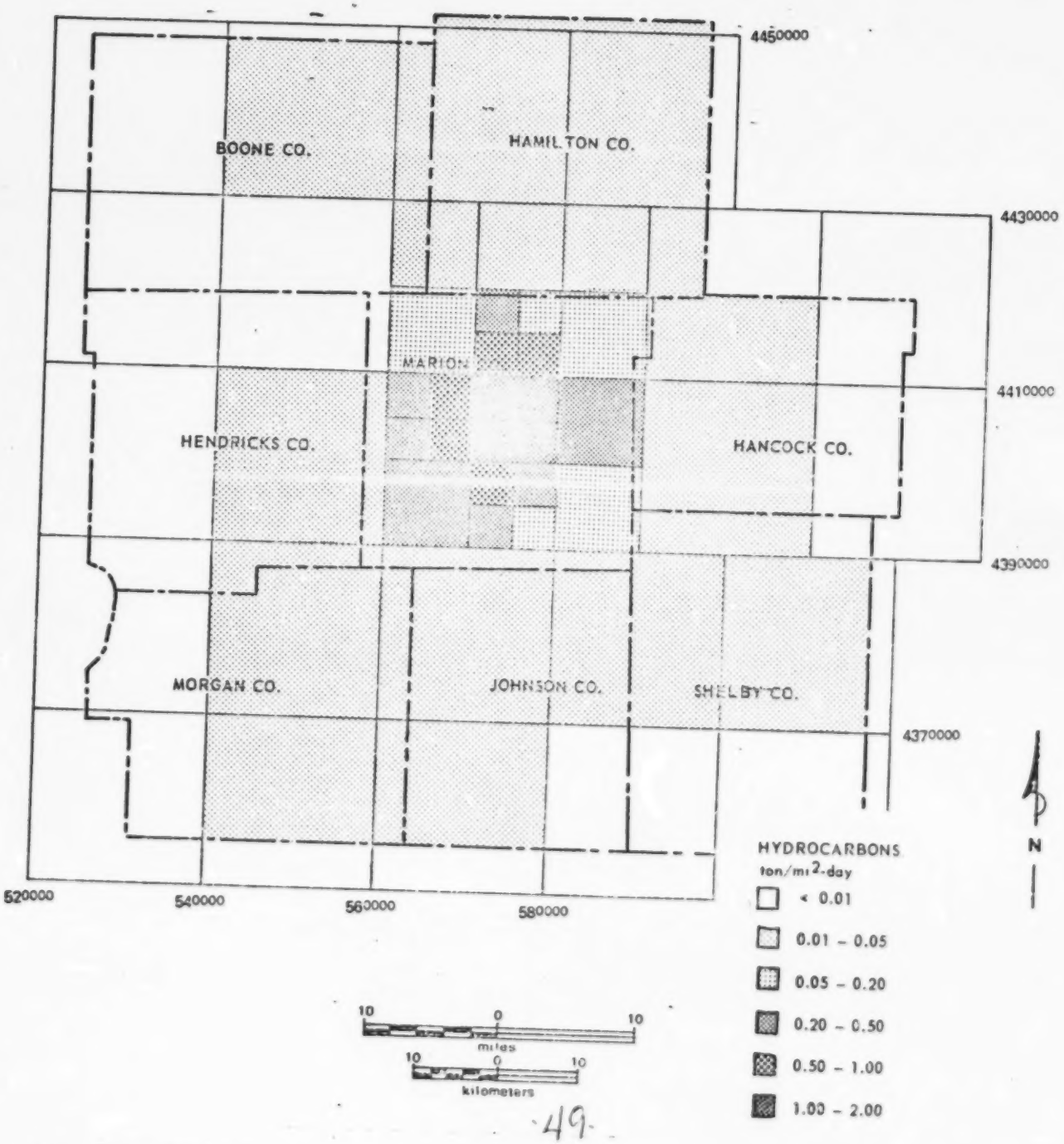


Figure 8. Hydrocarbon emission density from all sources surveyed in the Indianapolis study area, 1967.

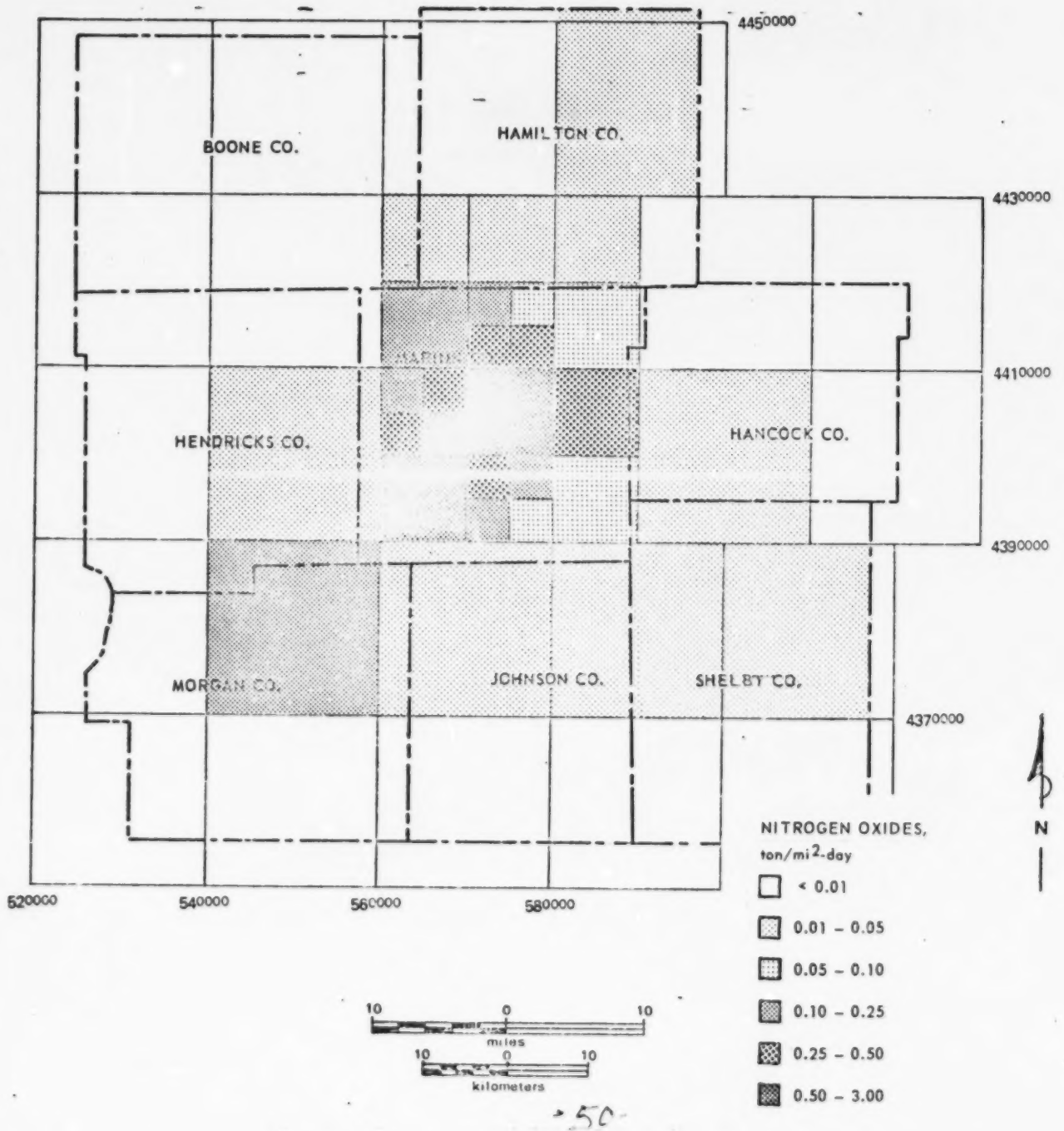


Figure 9. Nitrogen oxide emission density from all sources in the Indianapolis study area, 1967.

REFERENCES

1. Ozolins, G. and Smith, R., Rapid Survey Technique for Estimating Community Air Pollution Emissions, Department of Health, Education, and Welfare, Public Health Service, October 1966.

2. Duprey, R. L., Compilation of Air Pollutant Emission Factors, Department of Health, Education, and Welfare, Public Health Service, April 1967.

3. Personal contact with local coal dealers and suppliers, October 1968.

4. Burner Fuel Oils, Mineral Industry Surveys, United States Department of the Interior, Bureau of Mines, 1965.

5. Personal contact with the Indianapolis Bureau of Air Pollution Control, October, 1968.

6. Census of Housing, United States Department of Commerce, Bureau of the Census, 1960.

7. Air Traffic Activity for 1967, Department of Transportation, Federal Aviation Administration.

8. Personal contact with NCUIH, United States Department of Health, Education, and Welfare, Public Health Service, August 1968.

9. Indianapolis Regional Transportation and Development Study, 1966.

10. Retail Trade Special Report, Census of Business, United States Department of Commerce, Bureau of the Census, 1963.

11. Highway Statistics, United States Department of Transportation, Federal Highway Administration, Bureau of Public Roads, 1965.

STATE OF INDIANA

INDIANAPOLIS

STATE BOARD OF HEALTH

Address Reply to:
Indiana State Board of Health
1330 West Michigan Street
Indianapolis, Indiana 46207

November 4, 1968

Mr. Clyde B. Morita, Sr. Asst. San. Engr.
National Air Pollution Control
Administration
NIAPEC Section
411 West Chapel Hill Street
Durham, North Carolina 27701

Dear Mr. Morita:

Attached is information for the proposed Indianapolis Region, including Marion County and the seven contiguous counties. This material includes:

1. One sheet of notes on Shelby County with process information on Pittsburgh Plate Glass Company.

2. Comprehensive data, provided by Mr. Leo M. Lototzky, of Pickands Mather & Company, on coal usage in the eight counties being studied. This is categorized as Commercial and Retail, Industrial, and Utilities, including data on ash and sulfur content.

3. Comprehensive data, provided by Mr. John E. Cockley, of Indiana Gas Company, Inc., on gas usage in the six contiguous counties that they service. This is categorized as Commercial and Retail, and Industrial. It includes typical winter and summer usage to enable you to form an opinion on needs for space heating requirements. Hancock County gas usage for 1967 was 1,578,000,000 cubic feet, according to the Greenfield Gas Company, Inc.

We were unable to obtain any information on fuel oil usage for this proposed region through the Indiana Petroleum Council, since only a portion of the fuel oil distribution is handled by members of the Council. The information you have from the Oil Fuel Institute of Central Indiana will have to suffice.

We trust that these data will enable you to complete the survey. If we can be of further assistance, please contact us.

Very truly yours,

53

Harry D. Williams

Harry D. Williams, Director
Air Pollution Control Division

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Encls.

Louisiana Gas Service Company

U.S. Labor Statistics Industrial Survey 1967

Light Manufacturing Industries Classification

Location	Production Workers Number	Production Workers Man-hours	Office Workers Number	Total Payroll	Month	Overtime Hours	Month	Shift Differential
Gonzales	440297.2	205222.9	64131.4	709651.5	August	15026.5	February	108529.5
Hammond	554543.4	258163.7	81094.5	893801.8	August	25651.6	February	136241.1
Jennings	—	—	—	None	—	—	—	—
Lake Charles	134759.6	65668.8	—	210418.4	August	4623.8	March	35537.0
Opelousas	1083292.8	513342.5	295395.3	1377650.6	August	60081.9	March	347285.1
Shreveport	—	—	—	None	—	—	—	—
Morgan City	612172.4	262782.0	144216.6	1316870.0	August	137515.2	March	282661.3
Shelby	740070.6	361656.2	154719.8	1674476.6	July	134591.9	January	317301.9
TOTAL	3565134.2	2096535.1	3405702.6	9667322.9				

NOT REPRODUCIBLE